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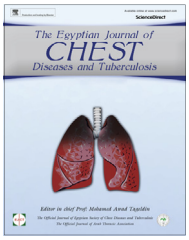

ORIGINAL ARTICLE

Early versus late percutaneous tracheostomy in critically ill adult mechanically ventilated patients

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KEYWORDS

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Abstract *Introduction:* Critically ill patients frequently require tracheostomy to simplify long term air way management. While tracheostomy indications have remained unchanged, the timing of elective tracheostomy for the ventilated patient has been questioned.

Aim of the work: This study was performed to compare the differences between early and late percutaneous dilatational tracheostomy (PDT) regarding, mechanical ventilation duration (MVD), length of ICU stay, length of hospital stay, incidence of ventilator associated pneumonia and hospital outcome.

Patients and methods: Forty patients who met the inclusion criteria were randomly divided into early PDT who had the tracheostomy within the first 10 days of mechanical ventilation (MV) and the late PDT who had the tracheostomy after 10 days of MV. On admission, demographic data and Acute Physiology and Chronic ill Health II and GCS were collected. The duration of mechanical ventilation, ICU length of stay (LOS) and hospital LOS were all calculated.

Results: Total of 40 patients were randomized to either early PDT ($n = 20$) or late PDT ($n = 20$). There were no significant differences between both groups regarding demographic data or the scores: APACHE II (22.75 ± 7 vs 24.35 ± 8) and GCS (6.10 ± 2 vs 7.10 ± 2.71). An early PDT showed fewer complications vs late procedure, however it was insignificant. There were significant differences between the two groups regarding mean (MVD) which was shorter in early PDT

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than the late PDT group (32.2 ± 10.5) vs (20.6 ± 13 days; $p = 0.004$). Mean ICU stay was shorter in early PDT than late PDT (21 .0 ± 513.4) vs (40.15 ± 12.7 days; $p \leqslant 0.001$). Mean hospital stay was shorter in early PDT than late PDT (34.60 ± 18.37) vs (55.60 ± 25.73 days; $p = 0.005$). Patients with early PDT suffered less sepsis and VAP than late PDT, there was no difference regarding the mortality rate between the two groups.

Conclusion: Early PDT is recommended for patients who require prolonged tracheal intubation in the ICU as outcomes like the duration of mechanical ventilation length of ICU stay and hospital stay were significantly shorter in early tracheostomy.

Introduction

Critically ill patients frequently require tracheostomy to simplify long term airway management [1]. While tracheostomy indications have remained unchanged, the timing of elective tracheostomy for the ventilated patients has been questioned [2,3]. Tracheostomy is among the most frequently performed procedure in critically ill patients, being done in about 24% of patients in ICU [4]. A tracheostomy is commonly performed when clinicians predict a patient will need prolonged mechanical ventilation [5]. The exact ''best'' timing for performing tracheostomy has not been clearly determined, but available data do suggest that ''earlier'' is better than ''later'' [6,7]. The perceived advantages of a tracheostomy over prolonged trans laryngeal endotracheal intubation include improved patient comfort and reduced sedative drug use, faster weaning from mechanical ventilation, a reduced incidence of nosocomial pneumonia, and shorter hospitalization [8,9]. The incidence of ventilator-associated pneumonia is related directly to the duration of mechanical ventilation which is a complication that carries significant morbidity and mortality [10]. So the beneficial effects might be maximized if tracheostomies were performed early in a patient's illness. However, one study reported in 1981 [11] that the incidence of tracheal stenosis after tracheostomy was raised up to 65%. In spite of that, the incidence of tracheal stenosis has decreased substantially with recognition of its etiology and improvements in tracheostomy materials, design and management, particularly with the use of high-volume, low pressure cuffs [12]. Finally, evidence to guide practice has been limited. In 1989, the National Association of Medical Directors of Respiratory Care recommended that trans laryngeal (endotracheal) intubation be used only for patients requiring less than 10 days of artificial ventilation and that a tracheostomy should be placed in patients who still require artificial ventilation 21 days after admission [13]. Although these recommendations are based only on expert opinion, modern practice broadly seems to follow them [14].

Patient and methods

This is a prospective randomized study which was conducted in the King Faisal Hospital of Makkah/K.S.A and the Kasr Alaini Cairo University Hospital /Egypt on forty patients who underwent bedside percutaneous dilatational tracheostomy (PDT) using the Ciaglia's method [15] in the critical care departments (from October 2012 to October 2013). Informed written consents were taken from the next of kin, and the study was approved by the local hospital's ethics committee. Patients included in the study were older than 18 years, mechanically ventilated for respiratory failure > 24 h and has no previous pulmonary infection by chest X-ray. The clinical assessment of the severity of their illness by APACHE II score was equal or more to 15. We excluded patients with a history of anatomical deformity of the neck (including thyroid gland enlargement), cervical tumours history of esophageal, tracheal or pulmonary cancer, and soft tissue infection of the neck, hematological malignancies, terminal malignancy, and terminal liver cell failure but were admitted to the ICU for other reasons.

By protocol, patients who met the inclusion criteria were randomly divided into 2 groups the early group and the late group. The early tracheostomies were placed within 10 days of mechanical ventilation and the late tracheostomies were placed after 10 days of endotracheal tube insertion. All other care was at the discretion of the treating clinicians. During the first 24 h in the critical care unit, clinicians recorded patients' data. Details of the tracheostomy procedure were collected including timing, immediate and late complications. Treatment assignment could not be blinded to the caring team or to the analysis team because it was apparent from the data to which group a patient had been assigned. Patients were randomly assigned in a 1:1 ratio, either to early tracheostomy or to late tracheostomy. From randomization, daily information on respiratory support was recorded .We extracted data on all consecutive patients admitted to the ICU over a one-year period. Data were collected on demographics and admission severity of illness, estimated using the Acute Physiology and Chronic Health Evaluation (APACHE) II [16] and Glasgow Coma Score (GCS). Data included Complete blood picture, Coagulation profile before tracheostomy, BUN, Creatinine, Liver functions, Electrolytes and Cultures of samples from sputum, blood, and urine. The number of days from the initiation of ventilation to tracheostomy, from tracheostomy to weaning (the duration of mechanical ventilation), from tracheostomy to discharge from ICU (length of stay) and hospital length of stay were all calculated. All these durations were calculated as the number of calendar days. ICU and hospital mortality rates were documented.

The data were analyzed using STATA 8.2 and SPSS 17.0; appropriate techniques were applied after checking necessary assumptions. Variables, which were non-normally distributed, were normalized by applying Box–Cox transformation. Mean ± SD is given for normally distributed metric variables, frequencies and percentages are given for non-metric variables. Shapiro–Wilk test was used to test normality. Independent sample t test was applied to observe mean differences among two groups. Fisher's exact test was applied to observe

associations for qualitative variables. A p-value of <0.05 was considered statistically as significant.

Results

Demographic data: (Table 1)

The mean age of patients in early tracheostomy group was 55.30 ± 20.13 years and in the late tracheostomy group was 59.95 ± 18.47 years. Majority of the patients in both groups were males as compared to females however, no statistically significant difference was observed between both groups concerning the age and gender. Also, the mean body mass index (BMI) of patients in early tracheostomy group was 27.33 ± 6.34 and in the late tracheostomy group was 27.25 ± 5.61 with no statistically significant difference.

Admission diagnosis: Table 2

In the present study, the number of patients who had type II respiratory failure was significantly higher in the late group than the early group, while traumatic brain injury patients were significantly more in the early group. However, no significant associations were observed between the remaining "diagnosis" and tracheostomy timing.

Clinical and lab data

There was no statistically significant difference between both groups regarding the mean GCS (in early tracheostomy group was 6.10 ± 2.07 and in late tracheostomy group was 7.10 ± 2.71, $p = 0.198$) or APACHE II score (in early tracheostomy group was 22.75 ± 7.40 and in late tracheostomy group was 24.35 ± 8.36, $p = 0.526$). Regarding laboratory data, no statistically significant difference was observed concerning CBC, PT, INR, chemistry, blood, in both groups. However, APTT was significantly high in late tracheostomy group as compared to the early tracheostomy group (33.47 ± 6.46 vs 38.43 ± 8.41, $P = 0.044$), but both readings were within normal limits.

Table 1 Demographic characteristics of patients in both groups.

	Early tracheostomy	Late tracheostomy	*P*-value
Age	55.30 ± 20.13	59.95 ± 18.47	0.451
Gender M/F	19/1	14/6	0.091
BMI	27.33 ± 6.34	27.25 ± 5.61	0.964

Complications of PDT: Table 3

Evaluation of tracheostomy related complications during hospital stay showed that there was no statistically significant association between intra-operative and post-operative complications in early and late tracheostomy timing. However, the percentage of complications was observed to be more in late tracheostomy as compared to early tracheostomy Fig. 1.

Outcome of patients

Hospital mortality: Tables 4a and 4b

In the present study, there was no statistically significant difference in the mortality outcome of patients in early and late tracheostomy groups. Multivariate analysis relating mortality to diagnosis on admission & tracheostomy timings did not show any statistical significant association.

Mechanical ventilation duration (after performing PDT), ICU stay, hospital length of stay: Fig. 2

Early tracheostomy was associated with a significantly shorter duration of mechanical ventilation (20.60 + 13.03 vs 32.20 ± 10.52 $p = 0.004$), shorter ICU stay (21.05 ± 13.46 vs 40.15 ± 12.72 days; $p < 0.001$) and shorter hospital length of stay (34.60 ± 18.37 vs 55.60 ± 25.73, $P = 0.005$).

Table 2 The diagnosis on ICU admission.

	Early tracheostomy $n = 20$		Late tracheostomy $n = 20$		Test of significance
	N	%	*N*	%	
Traumatic brain injury (CI, SAH, SDH, EDH)	10	50.0	07	35.0	Fisher exact $p = 0.028$ (S)
Cerebrovascular accident CVA	05	25.0	5	25.0	Fisher exact $p = 1$ (NS)
Renal failure (Acute + Chronic)	03	15.0	03	15.0	Fisher exact $P = 1$ (NS)
Respiratory failure (type II, COAD)	02	10.0	4	20.0	Fisher exact $p = 0.049$ (S)
Tetanus	0	0.0	1	5.0	Fisher exact $p = 0.311$ (NS)

Table 3 Intra-operative and postoperative complications.

Variables	Early tracheostomy $n = 20$		Late tracheostomy $n = 20$		Test of significance
	N	%	*N*	%	
Pneumothorax	01	5.0	02	10.0	Fisher exact $p = 0.548$ (NS
Sepsis	05	25.0	07	35.0	Fisher exact $p = 0.490$ (NS)
Ventilation associated pneumonia	04	20.0	08	40.0	Fisher exact $p = 0.167$ (NS)
Repeat PDT	01	5.0	0	0	NS

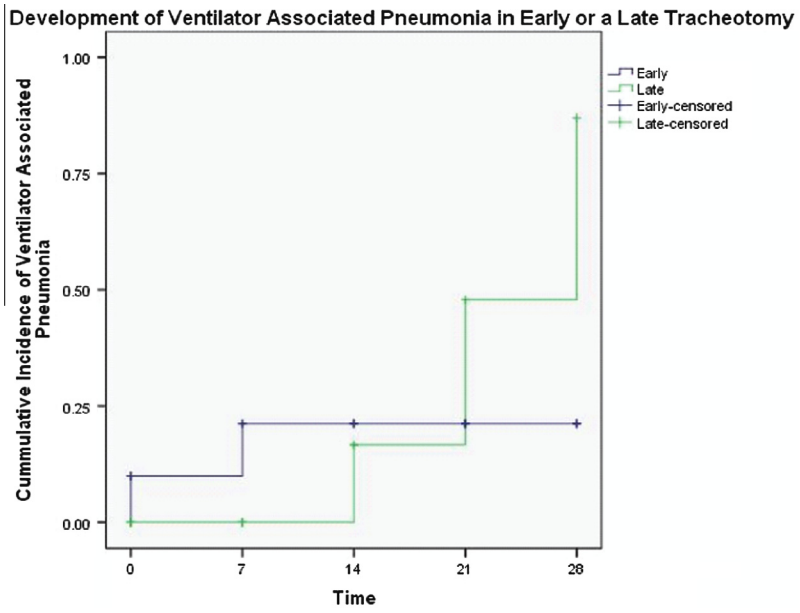

Figure 1 Showed the cumulative incidence of VAP in both groups. Concluded from this curve, the earlier the tracheostomy is done the lower is the risk for ventilation associated pneumonia.

Table 4a Hospital mortality.

Mortality	Early tracheostomy $n = 20$		Late tracheostomy $n = 20$		Test of significance
	n	%	*n*	%	
Dead	8	40	8	40.0	
Total	8	40	8	40.0	Fisher exact $p = 1.000$ (NS)

Table 4b Multivariate analysis for Mortality, Tracheostomy timing & diagnosis on ICU admission.

Diagnosis		Early tracheostomy Mortality		Late tracheostomy Mortality		Test of significance
		Yes *n* (%)	No n (%)	Yes n (%)	No *n* (%)	
[a]TBI:						
Cervical injury	Yes	0	0	01	02	Fisher exact $p = 0.305$ (NS)
	NO	08	12	07	10	
Subarachnoid hemorrhage	Yes	0	01	02	0	Fisher exact $p = 0.474$ (NS)
	No	08	11	06	12	
Subdural hematoma	Yes	04	02	0	0	Fisher exact $p = 0.087$ (NS)
	No	04	10	08	12	
Epidural hemorrhage	Yes	01	0	0	01	Fisher exact $p = 0.230$ (NS)
	No	07	12	08	11	
CVA	Yes	02	03	01	01	Fisher exact $p = 0.531$ (NS)
	No	06	09	07	11	
Renal failure	Yes	01	04	01	03	Fisher exact $p = 0.220$ (NS)
	No	07	08	07	09	
Respiratory failure	Yes	01	0	03	05	Fisher exact $p = 0.276$ (NS)
	No	07	12	05	07	
Tetanus	Yes	0	0	01	0	Fisher exact
	No	08	12	07	12	$P = 0.246$

[a] TBI: traumatic brain injury.

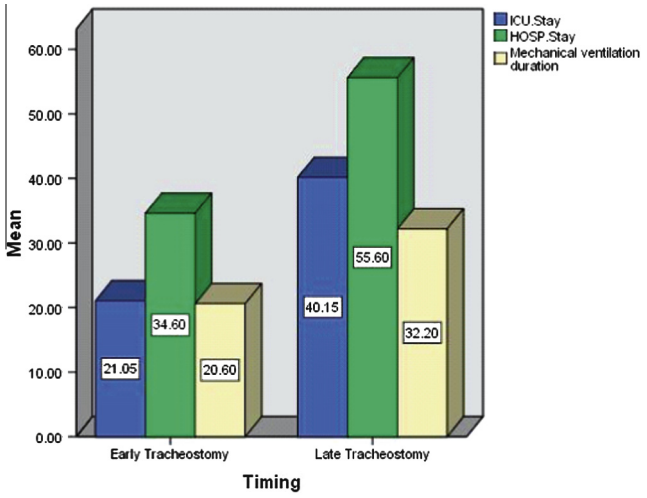

Figure 2 Mechanical ventilation duration, ICU and hospital stay in both groups.

Discussion

Several prospective randomized studies have shown that early tracheostomy resulted in a shorter time of mechanical ventilation, pneumonia and mortality compared to delayed tracheostomy [17,18]. However, there remains a considerable variation in the timing of tracheostomy between centers [19,20].

The aim of this work is to study the effects of early versus late (PCT) regarding mechanical ventilation duration, ICU stay, hospital stay, ventilator associated pneumonia (VAP), and hospital outcome. Accordingly we conducted a prospective randomized study on forty patients classified in two groups as early (before 10 days) and late (after 10 days) with twenty patients in each group. In the current study, the baseline demographic characteristics (Age, Gender, BMI), clinical variables on admission (APACHE II score, GCS), indications of percutaneous tracheostomy, comorbidities were homogenous between both groups without significant statistical differences. Trauma followed by cerebrovascular accident were the most frequent causes of ICU admissions that required tracheostomy which is probably due to the high rate of road traffic accidents. This agreed with results of Milo Engoren 2004 when four hundred twenty-nine patients after admission to the ICU were studied in retrospective chart review combined with prospective evaluation of functional status [21]. Also in a prospective study – done by Raees Ahmed et al. (2010), in medical- surgical ICU in Emirates for a total of 117 tracheostomised patients, around half of these patients [57(49%)] were Road Traffic Accidents resulting in traumatic brain injury and polytrauma [22].

The total percentage of intra-operative and postoperative complications in our study was (70%) as 28 patients of both groups had different complications during or post the procedure distributed for both early and late group during their ICU stay. Complications included Pneumothorax, sepsis, ventilator associated pneumonia (VAP). The percentage of complications was observed to be more in late tracheostomy however, this was not statistically significant. Studying the cumulative incidence of development of VAP in both groups was in favor of the early PCT compared to the late PCT. This was supported by Wise (2002), Fikkers (2004), and Yw Li (2009) [23–25]. Also, Rumbark et al. (2004) have provided powerful and convincing evidence in support of early tracheostomy, particularly for medical ICU patients who are expected to require prolonged mechanical ventilation and at high risk of VAP, sepsis and death [17].

Concerning the outcome of the patients included in this study, the main finding of our study was a significant shorter duration of mechanical ventilation in early tracheostomy group (20.60 ± 13.03 days in the early group versus 32.20 ± 10.52 in the late group).Our results were comparable to that reported by Gatti et al. (2004) and Zagli et al. (2010) but different from that mentioned by Terragni et al. (2010) [26–28].

In addition, the short duration of mechanical ventilation reflected on the mean ICU stay and the mean hospital stay which were significantly longer in the late group as compared to the early one. Our study confirmed by the results of Lee (2005) and also in agreement with the results of Zheng et al. (2012) who found that early PDT resulted in more ventilator free, sedation free, and in the patients ICU free days, higher successful weaning, and ICU discharge rate, and lower ICU incidence of VAP [29,30]. In the present study, there was no statistically significant association between mortality of patients in early and late tracheostomy. We have to stress that there are no deaths attributed to the procedure and all deaths related to late complications. Also multivariate analysis for relating mortality to the timing of tracheostomy or admission diagnosis did not show any significant result in both groups. Comparable results were reported by Fei Wang et al. (2011) and Koch et al. (2012) – which were carried out in the department of surgical ICU for 2 years over 100 critically ill – and demonstrated that mortality was not significantly reduced in the early tracheostomy group in contrast to the late tracheostomy group [31,32].

More recently, Jean-Louis (2013), conducted a randomized study trial of early versus late PDT post cardiac surgery and concluded that there was no difference in mortality and infectious complications (VAP) [33]. Also, another study done by Duncan Young (2013) showed – among mechanically ventilated critically ill patients in adult, general critical care units in the United Kingdom – that early tracheostomy (within the first 4 days after admission) was not associated with an improvement in 30-day mortality [34].

Limitations

Our studied population was small. For that reason, further studies with a larger population must be carried out to confirm the favorable results obtained in this study. As our study was not blinded, a potential performance bias could have influenced our outcomes because the decision to wean the patients was left in the end to the discretion of the ICU attending physician. We controlled such factors by strictly following the policy of ICU.

Conclusion

Among mechanically ventilated critically ill patients in adult general critical care units in the current study, early tracheostomy (within the first 10 days after admission) was not

associated with an improvement in hospital mortality but other important secondary outcomes like the duration of mechanical ventilation, length of ICU stay and hospital stay were significantly shorter in early tracheostomy.

Conflict of interest

None declared.

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